II. *Continuation of an Account of a peculiar Arrangement in the Arteries distributed on the Muscles of slow-moving Animals, &c. In a Letter from Mr.* Anthony Carlisle *to* John Symmons, *Esq. F. R. S.*

Read December 8, 1803.

DEAR SIR,

You did me the honour of presenting to the Royal Society, An Account of a Peculiarity in the Distribution of the Arteries sent to the Limbs of slow-moving Animals.* According to my intention expressed in that letter, I have, since that time, endeavoured to collect farther illustrations of the connection between the disposition of the blood-vessels and the actions of muscles. Neither the tribe of ruminating, nor the carnivorous animals, have afforded the evidence which I had expected, from the investigation of their masseter, pterygoid, and temporal muscles; since these are all supplied by the ordinary arborescent arteries. The rete mirabile, in such animals, seems to be a contrivance to restrain that velocity of the blood which their habits and figures would otherwise produce, in its passage to the brain. The circuitous course of all the arteries which supply the human brain, and their confinement in bony passages, is obviously for a similar purpose. Having sought for examples in other directions, the following results have occurred.

In the human body, two small arteries arise from the upper

* See Phil. Trans. for 1800, p. 98.

part of the abdominal aorta, and, in men, descend from thence to the testicles: they are usually but two in number, and are called the spermatic arteries. Through an extent of ten inches, by average computation, these vessels give off comparatively few lateral branches, so that they may be properly considered as the longest arterial cylinders in the body. The spermatic arteries supply the muscles called cremasters, which suspend the testicles, and the fibrils of the dartos, which corrugates the scrotum. The slow actions of these muscles, and their occasional long continuance in a contracted state, are sufficiently known. The next in resemblance are the intercostal arteries; and lastly those of the diaphragm. Now the slowness of the muscular actions in respiration, and the occasional duration of arbitrary actions in these muscles, need only to be mentioned. Whether the peristaltic motions of the alimentary canal be influenced by the circuitous course of some of the arteries, and their numerous junctions, I am unable to determine; but these arteries are distributed differently, in those respects, from the arteries of ordinary muscles.

The iris, in man, and in animals, is furnished with cylindrical arteries, which pierce the posterior part of the globe of the eye, and finally enter that muscle by a circuitous course.* The pupil of the eye contracts slowly, and is occasionally required to continue long in that state.

The instance of an opposite mode of distribution, is to be found in the coronary arteries which supply the heart, a muscle whose actions are more rapid than those of any other; at the same time it is observable, that the coronary arteries are more

* Vide ZINN. *Descriptio anatomica Oculi humani,* Plate 3, Fig. 2, *b b,* and Fig. 1, *m n.*

quickly subdivided than the arteries of muscles generally. The alteration which the blood undergoes during the supply of this muscle only, is worthy of remark, *viz.* that the coronary veins return venous blood apparently as much changed from the arterial state, as if it had passed through the remotest organs of the body.

Any impediment to the accustomed course of the blood flowing through muscles, induces a corresponding diminution in their powers of action. When the principal arterial trunk which supplies the muscles of the leg is obliterated by ligature, for the cure of an aneurism, the leg remains afterwards much weakened in its muscular strength, until the circuitous vessels have again restored a vigorous supply of blood.

Animals with prehensile tails, such as certain monkeys and opossums, have the muscles of their tails supplied by one cylindrical artery; and the length of time they can suspend themselves by their tails is remarkable, notwithstanding the assistance derived from the repetition of coils around the bough of a tree, and occasionally from an elastic bend in the extreme joints of some prehensile tails.

The swimming-bladders of some fishes afford another example of cylindrical arteries supplying the muscular parts of them. (See Plate I. Fig. 1.) That these parts are truly muscular, I have ascertained by their excitation with the GALVANIC metals. The swimming-bladders appear destined to assist the fish in rising or descending in the water, as well as to keep the back upwards when at rest; so that their muscular actions are probably of slow performance, and require to be of long continuance.

The intestinum ileum of the Cavia Aguti has a similar disposition of blood-vessels; from which I was led to consider the

arteries of the alimentary canal in other animals; and, in many of them, this extension of undivided vessels is to be found. See Fig. 2.

Many of the amphibious class of animals are slow in their motions, such as the tortoises, lizards, and toads; but, whether they can also continue their muscular actions longer than in ordinary cases, I do not know. The blood circulates more slowly in the amphibia; and their respiration is not so important to the vital functions. It cannot however be omitted, that many of the serpents, and some lizards, are very agile.

During the state of contraction, as has been often noticed, the muscles of animals with red blood become of a paler colour, and recover their former redness on the subsequent relaxation; it may therefore be affirmed, that muscular fibres are not distended with blood when in the state of contraction, but that the replenishing with blood is to supply some fresh material, which is employed in muscular action. Whatever substance this may be, it is less required for the irritability of the muscles in some animals than in others. Temperature, and the organs of respiration, seem to be intimately connected with these differences; but all illustrations of such points would extend beyond the limits of the present inquiry.

It has been shewn, that slowness of muscular action, and extraordinary duration of the contractions, are frequently united; and that such unusual phenomena in muscles, are accompanied with a peculiar distribution of the arteries which supply them: but, whether the slowness or the duration be the principal end, or whether the equable supply of blood by a set of appropriate arteries, be the only adaptation convenient for the peculiar offices of such muscles, are subjects not easily determined.

I have considered the accompanying figures of the arteries on the swimming-bladder of the tench, as a striking additional illustration of the subject, though they have been often noticed before, and occasionally ill represented. The intestinum ileum of the aguti is also figured, to show the same kind of distribution. The vessels in both having been injected, for the purpose of a clearer representation.

References to the Figures, Plate I.

Fig. 1 represents a side view of the double swimming-bladder of the tench. *(Cyprinus Tinca.)* The arteries on one side of the hinder bladder being drawn as they appear when injected. The upper portion of the bladder is devoid of those kind of vessels, and does not appear to be muscular. In the hinder portion of the swimming-bladder of the barbel, *(Cyprinus Barbus,)* these parallel cylinders wind spirally round the bladder, instead of proceeding straight forward along the sides.

a, The ductus pneumaticus entering the hinder portion of the vesica aerea.

b, The trunk of the artery from whence the bundles of cylinders are distributed.

c, The upper portion of the vesica aerea, which is covered by a thick, white, opaque, tender membrane.

Fig. 2. The intestinum ileum, and part of the cæcum, of the Cavia Aguti; the vessels being distended with quicksilver.

a, *a*, *a*, The intestinum ileum.

b, Part of the appendix vermiformis.

c, Part of the cæcum.

d, *d*, Anastomosing vessels, crossing the cylinders at right angles, and uniting with each of them.

Future researches in natural history seem to promise a more ample, and a clearer view, of the gross arrangements which attend the structure of muscles; a state of knowledge which will lead physiologists to determine between the essential connections, and the appendages of convenience belonging to muscles, and thereby to see more correctly, the immediate phenomena of muscular actions.

I am, &c.

ANT. CARLISLE.

Soho Square,
Nov. 15, 1803.

Fig. 1.

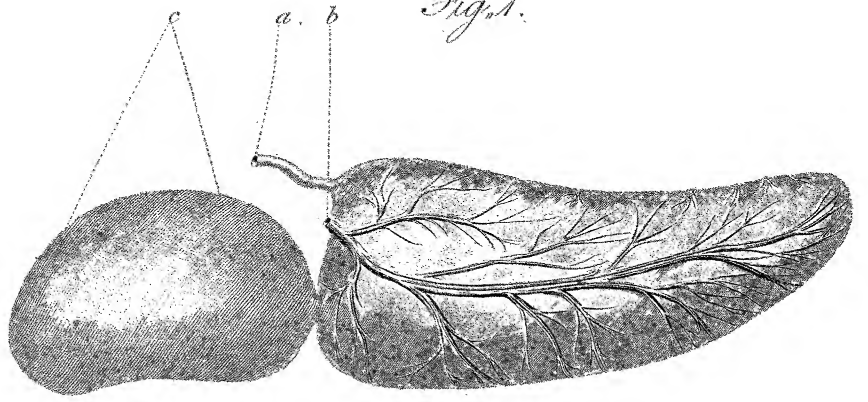
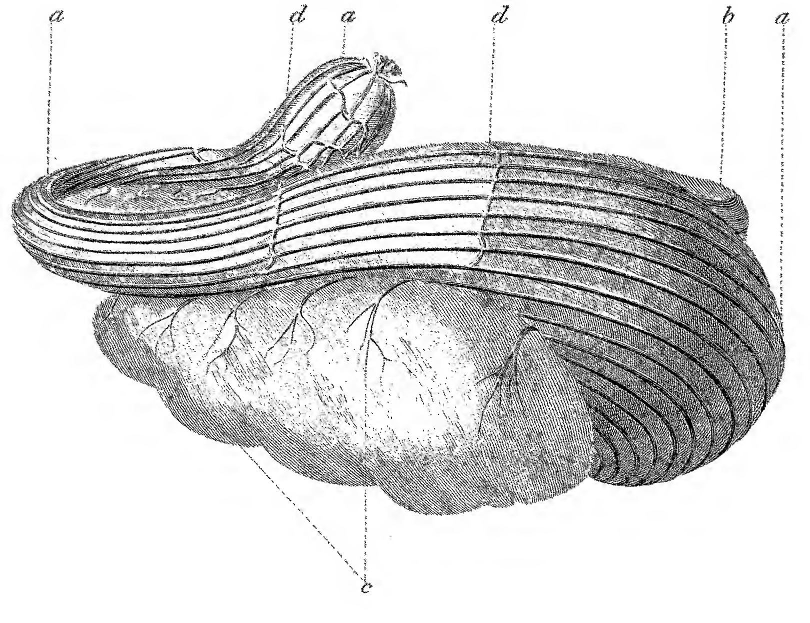


Fig. 2.



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